The Atacama Cosmology Telescope Project

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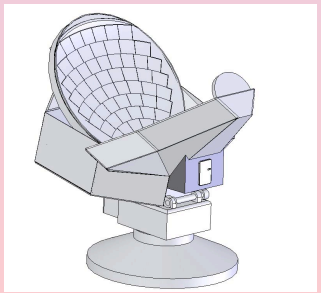


Outline

Outline

People and Places

Princeton Page (PI), Staggs, Fowler, Jarosik, Spergel, Lupton, Seljak, Shapley Penn Devlin, Jimenez, Verde, Jain Rutgers Hughes, Williams, Devlin Pitt Kosowsky NASA Goddard Moseley NIST Irwin, Doriese LLNL Wishnow UKZN (South Africa) Moodley, Cress Catolica (Chile) Quintana INAOE (Mexico) Hughes Columbia Miller Toronto (Canada) Netterfield UBC (Canada) Halpern Cardiff (UK) Ade, Mauskopf Haverford Partridge, Boughn U. Mass. Wilson

Funding

NSF Physics, NSF Astronomy

Program in International Research and Education

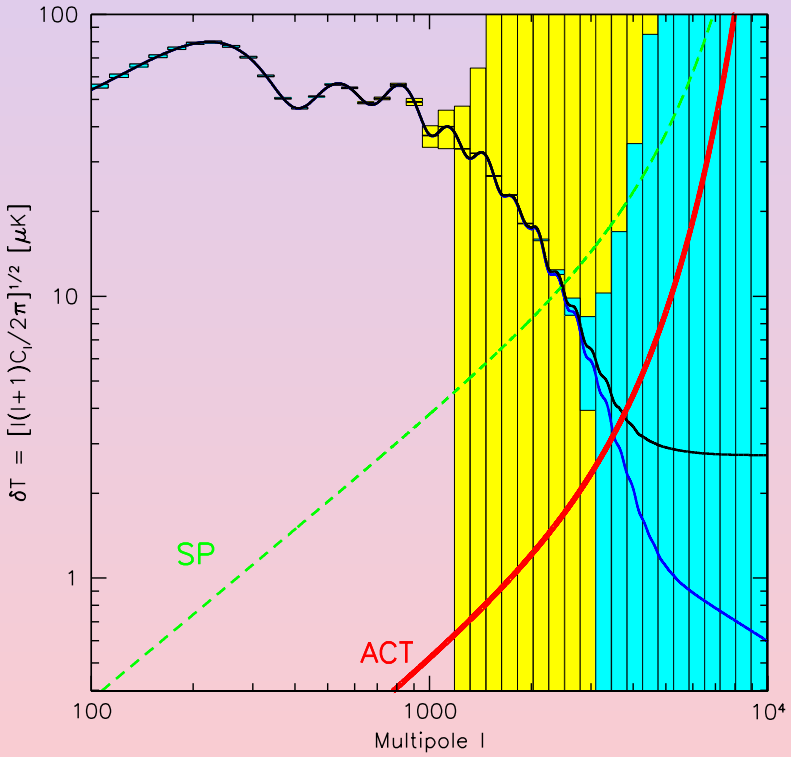
Outline

Technical Goals

- Map 200 square degrees of the microwave sky
- 3 frequency bands (145 GHz, 220 GHz, 265 GHz)
- Arcminute angular resolution (WMAP 14 arcminute, Planck 5 arcminute)
- 2 μK sensitivity per map pixel
- Complementary optical survey (4-band imaging to 24 mag in R, spectroscopic follow-up)

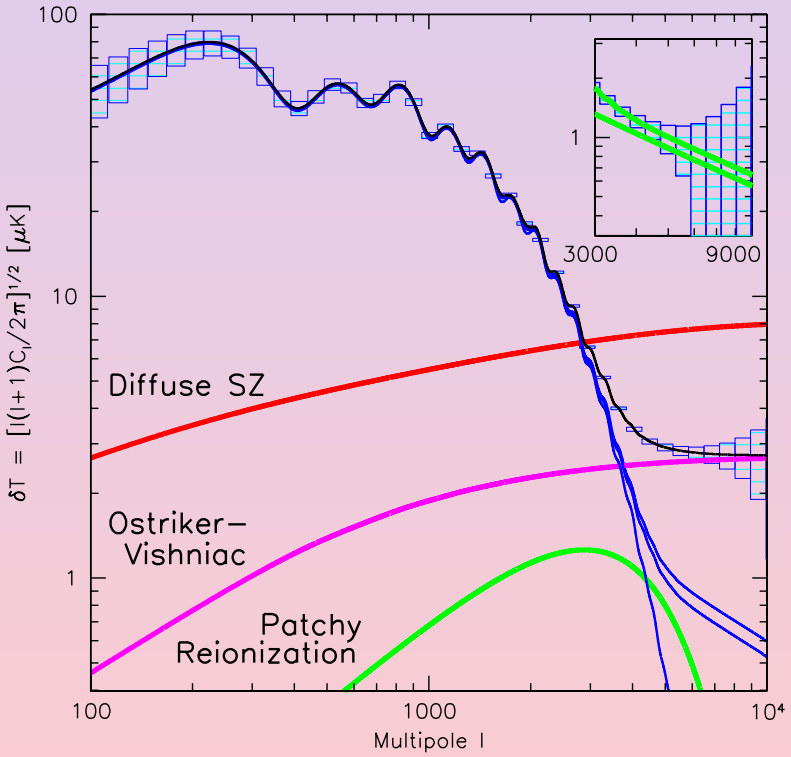
Outline

Primary Microwave Background Fluctuations



WMAP (yellow) and Planck (aqua) power spectrum error bars

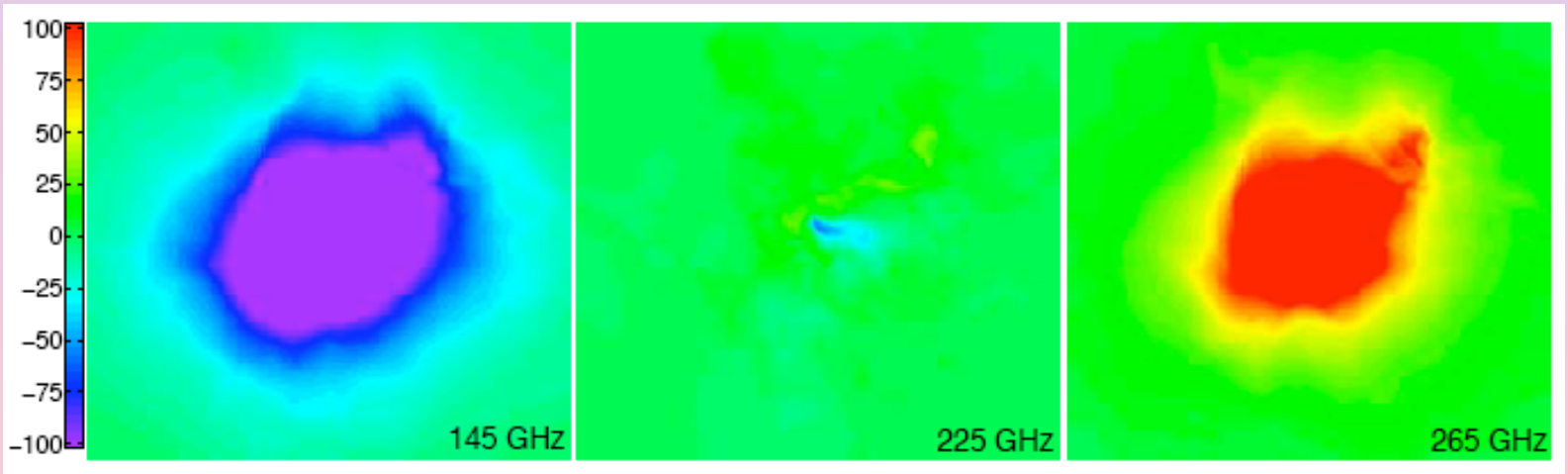
Primary Microwave Background Fluctuations



ACT measures entire linear regime to $l = 3500$

The Sunyaev-Zeldovich Effect

Galaxy clusters visible via the Sunyaev-Zeldovich Effect, independent of redshift, due to ionized gas pressure (up to $\simeq 80\mu$K) and velocity (up to $\simeq 5\mu$K).



$M = 10^{15} M_{\odot}$, $T = 9$ keV simulated cluster (Sehgal, Holder, AK 2005)

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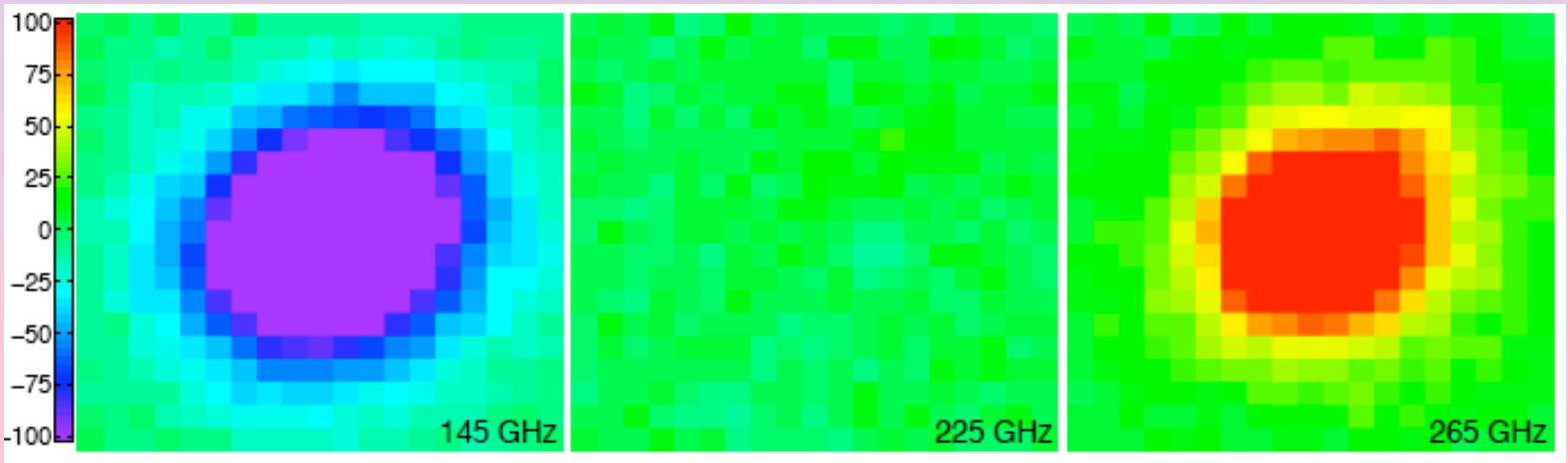
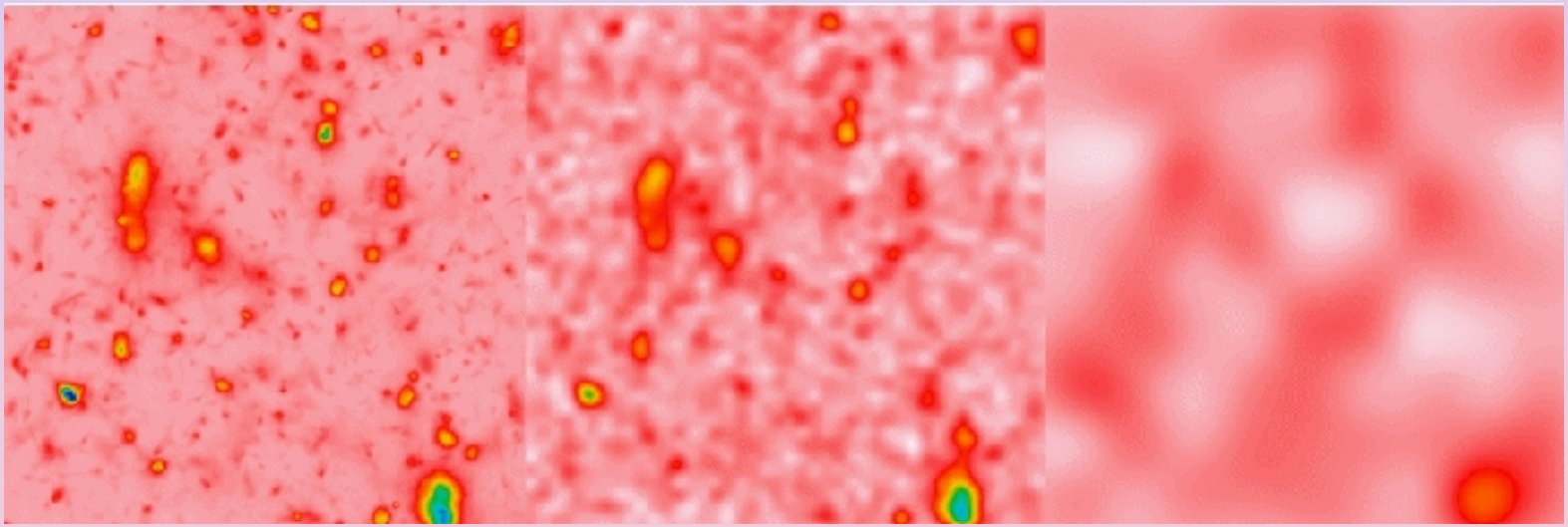


Same cluster at ACT resolution, sensitivity (Sehgal, Holder, AK 2005)

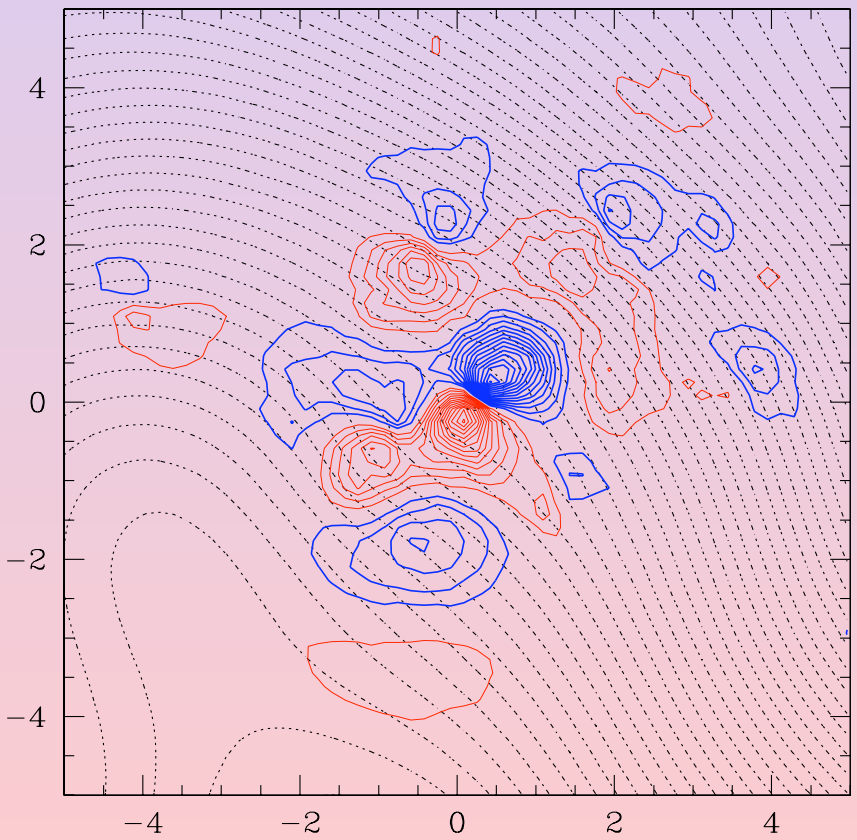
A Simulated SZ Sky



The 150 GHz Sunyaev-Zeldovich sky signal at infinite resolution (left), ACT resolution with double ACT noise (center) and Planck resolution and noise (right). (U. Seljak and J. Burwell 2000)

Gravitational Lensing

Mass distribution lenses microwave fluctuations (up to $\simeq 5\mu$K)



Simulated cluster
$M = 7 \times 10^{14} M_{\odot}$
(G. Holder and AK 2004)

Outline

Primordial Fluctuations

With power spectrum to $l = 3500$, ACT will test deviation from power-law primordial perturbation spectrum $P(k) \propto k^n$: constraint on inflation (AK and M. Turner 1996)

Dark Matter

ACT will provide constraints on dark matter via gravitational lensing: distinctive nongaussian patterns in temperature maps

Dark Energy

ACT will provide several independent dark energy constraints:

- Cluster number counts (but see Hu and Lima 2005; Francis, Bean, and AK 2005)
- Kinematic SZ signal (Hernandez-Monteagudo et al. 2005; Dedeo and Spergel 2005)
- Cluster galaxy differential ages serve as a chronometer (Jimenez et al. 2003)
- Microwave bispectrum (Verde and Spergel 2002)

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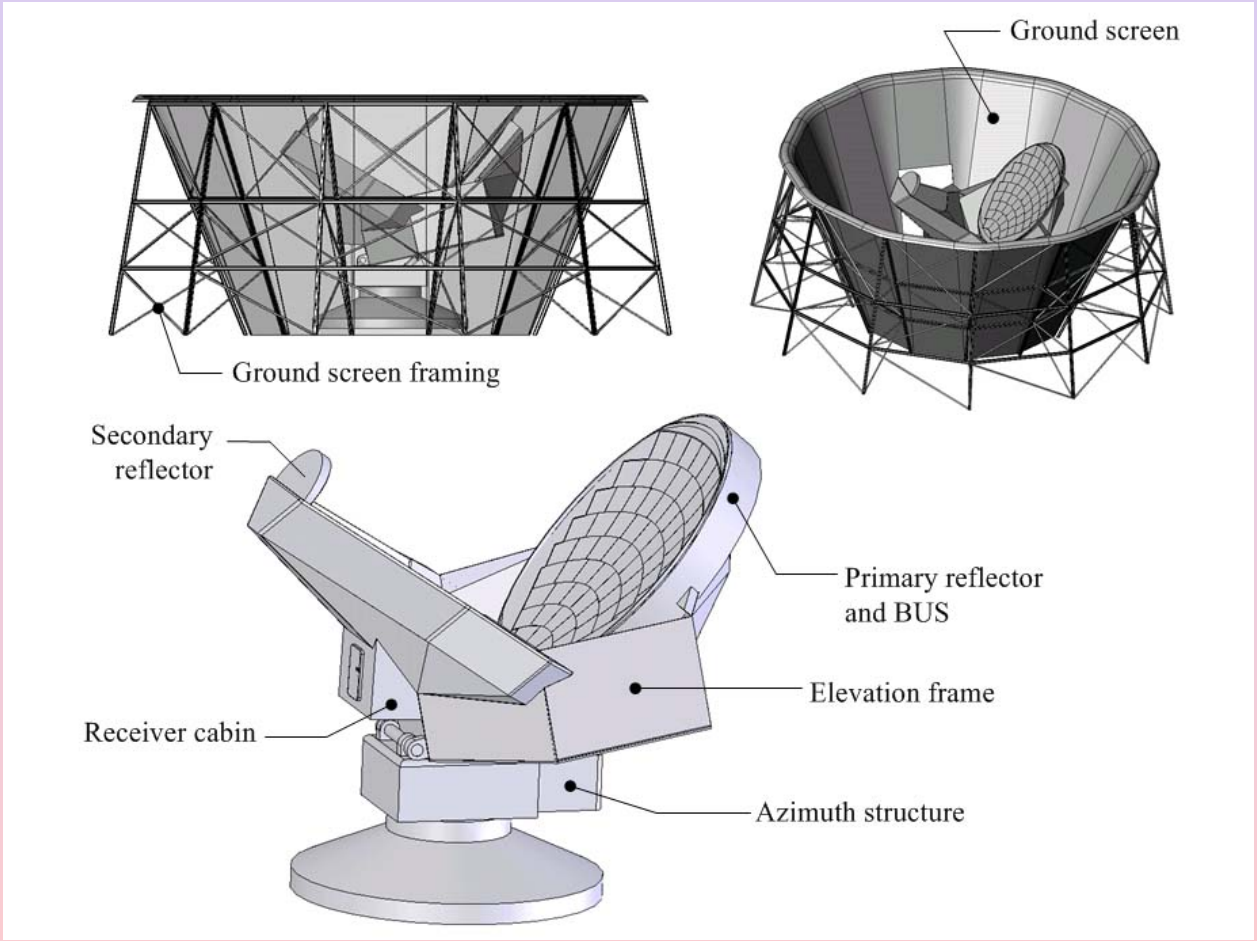
The Atacama Cosmology Telescope

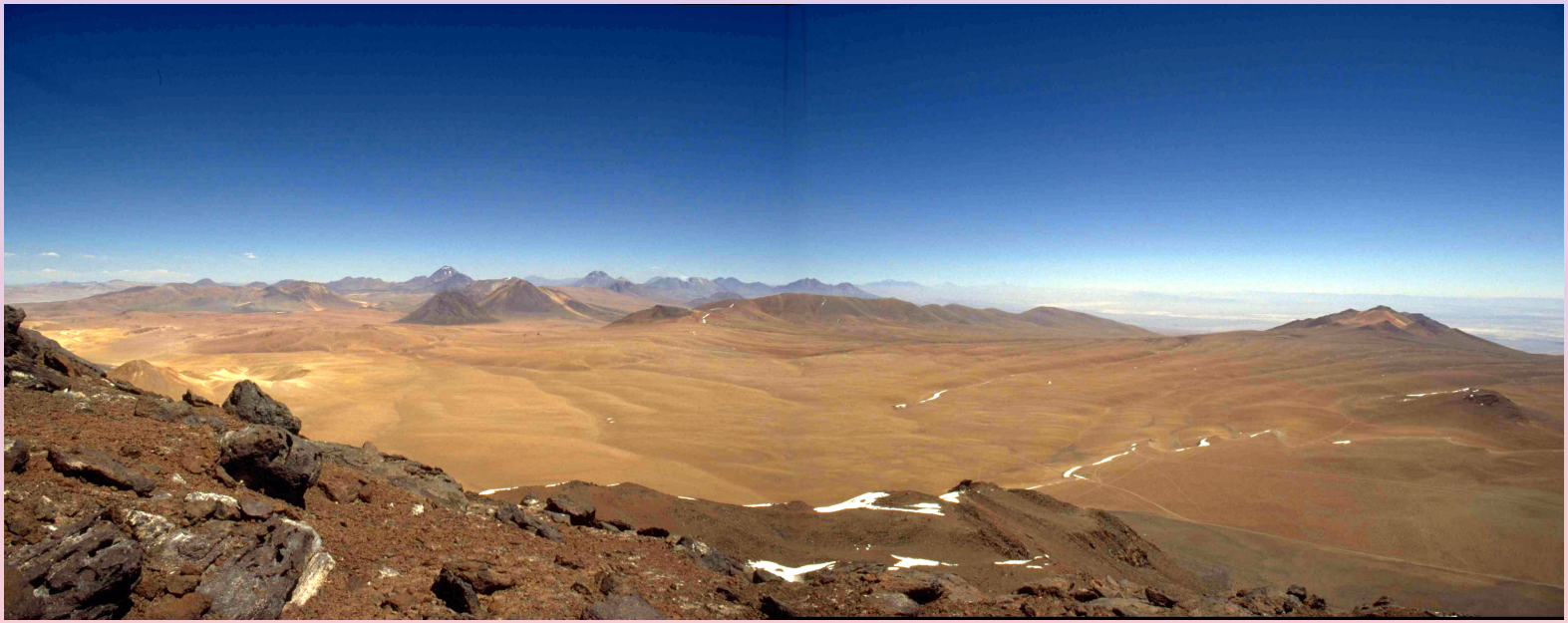


The Atacama Cosmology Telescope: Features

- Six meter primary reflector
- Micron surface tolerance
- Rotates through 3 degrees at 0.3 Hz: unchanging optical path
- Constant elevation during observations (atmosphere)
- 8-meter high ground screen

The Atacama

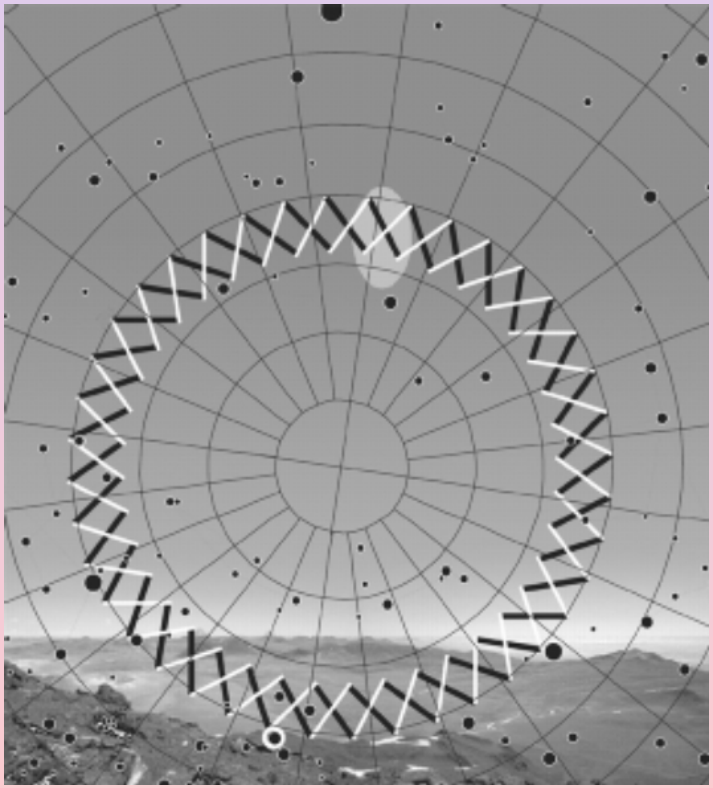
The Atacama Desert in the Chilean Andes is the driest place on Earth. Site is a 40-minute drive to San Pedro (population 10000).



View from Cerro Toco (elevation 17000 feet)

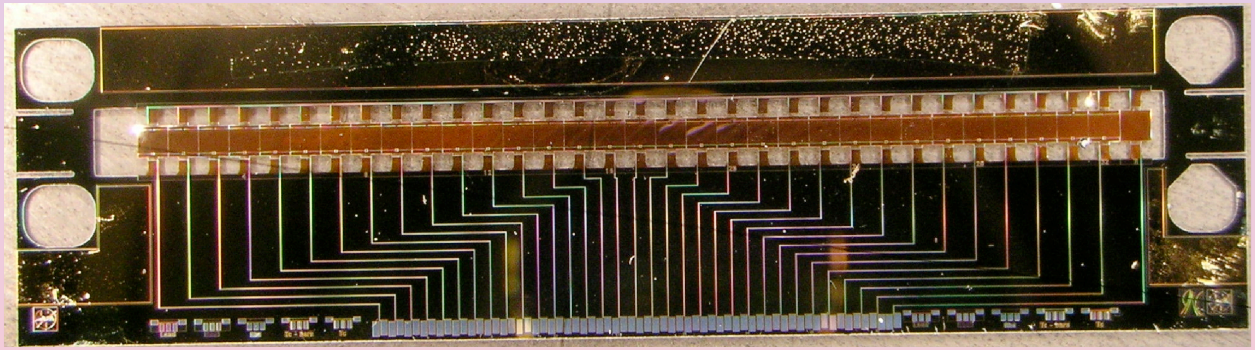
Sky Scan Pattern

Constant-elevation scans cover a strip at constant declination in one day. (ACT dec is -55.2°)



The Millimeter Bolometer Array Camera

Composed of 3 32×32 arrays of transition edge sensing bolometers (TES). Modular in rows of 1×32 bolometers. SQUID multiplexers. Pioneered by Moseley group at NASA Goddard.



One 32-bolometer row before folding

The Southern African Large Telescope

An 11-meter optical telescope with a spherical primary and correcting secondary (South Africa, Rutgers, 6 others)

Outline

Status and Schedule

- ACT Telescope: design complete, construction nearing completion. Test deployment (Vancouver) December 2005. Engineering deployment (Chile) July 2006. Science Observations June-Dec. 2007 and 2008.
- MBAC Bolometer Arrays: test "camera" nearly complete (1x32 bolometers), testing in Princeton and Vancouver. 2006 engineering run with 1 array up to 32x32 bolometers. Fabrication of three 32x32 arrays by spring 2007.
- SALT telescope: first light September 2005. Dedication Nov. 12 2005. Shared-risk commissioning observing until then.
- Current 2-year optical survey using MOSAIC on the 4-meter Blanco Telescope at CTIO. Applications for XMM (X-ray), Gallex (UV), and Spitzer (IR) time submitted or planned.

The Competition

South Pole Telescope (SPT) is on a similar schedule. John Carlstrom, U. Chicago (PI). Plans to map larger region at shallower depth with similar resolution and frequency coverage.